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THE DES MOINES RAPIDS OF THE MISSISSIPPI RIVER,
AND ITS IMPROVEMENTS.

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The Des Moines, or Lower Rapids, are situated near the mouth of the Des Moines river, and extend from Keokuk to Montrose, a distance of eleven miles.

Above these rapids the contour lines of the range of bluffs on either side, indicate that at some period in the history of the Mississippi Valley, the river widened, and assumed the dimensions of a small lake. There are several geological arguments which go to prove this fact.

The outlet of this lake was at the present head of the rapids. The waters, by their ceaseless action, through ages of time, aided by ice and other geological agencies, gradually eroded a channel through the rocks, until it has increased to its present dimensions.

The bluffs on each side of the river are contiguous to the shore line, and vary from one hundred to two hundred and fifty feet above the water. "The river bottom is a broad, smooth rock, seamed by a narrow, crooked channel, or, in some places, several of them, alternately widening and narrowing, shoaling and deepening; nowhere good navigation. The rapids, therefore, are not broken and noisy, but, the descent being gradual, the water flows over its bed in a broad, smooth, unbroken sheet, with nothing but the faintest ripple on its surface to indicate the dangerous places. The casual observer would not suspect the presence of the rapids, were he not informed beforehand." The character of the bottom is "cherty" limestone, belonging to the Keokuk group of the carboniferous series.

The fall in eleven miles is twenty-two feet; average width of Mississippi river, four thousand five hundred feet; its mean

depth, two and four-tenths feet; and its mean surface velocity is two and eighty-eight hundredths feet per second.

The tortuous, uncertain channel over these rapids precludes the possibility of any craft navigating them in low water. Even if the channel itself was wide and deep, no pilot would dare to undertake to pass them at night.

The worst portions of the rapids are called by river men, "chains," of which there are five principle ones. These "chains" are miniature ridges, stretching diagonally across the river, and, as before stated, have worn upon them a smooth surface, with a narrow channel, or a series of them, cut through by the action of the water. These chains lie between Keokuk and Nashville (Iowa), a distance of eight miles.

At Montrose, the head of the rapids, between the island and the main shore, there is an extensive "patch" of rock which requires excavation. The only feasible plan to remove this, will be to enclose the above "patches" by a coffer dam, pump the water out, and blast a channel two hundred feet wide and five feet deep. The question of improving the rapids has impressed itself upon the minds of the people of this country for many years past. The great want of it has been felt by steamboatmen. As early as 1830 the general government took steps to survey the locality, and made preparations for the improvement. The actual annual cost to river navigation on account of these rapids, for lighterage, reshipment by rail, &c., has varied from \$200,000 to \$600,000. No one can, therefore, deny the expediency of the great work required at this point. As the entire Mississippi Valley is directly interested in this matter, the people of the north-west have ever had an earnest desire to have the Father of Waters freed from all obstructions to commerce and travel. The will of these people has been repeatedly expressed by their representatives in commercial conventions, and elsewhere, and by that powerful exponent of popular thought, the press. The only question ever has been, how to make this improvement to best subserve the general interest.

The channel excavation at Montrose is estimated to cost \$620,000. From Nashville to Keokuk a fall of eighteen feet occurs, and, as it constitutes the most formidable barrier to navigation, it requires the most attention. It was, at one time, proposed to excavate a channel, in midstream, two hundred feet wide, and four feet deep, the entire length of the rapids. The objection to this, in addition to its great cost, would have been the danger of its navigation at night, and when windy; and as a boat would necessarily move slower, the proportionate difficulty of its management. Several other plans, such as the construction of a continuous dam, with locks across the entire stream, and various modifications of wing dams, sluices and chutes, for narrowing and deepening the thread of the current, have been suggested and carefully considered, but all rejected, as involving too many elements of uncertainty to warrant their application to a river of such magnitude as the Mississippi.

In 1837, Lieut. (since General C. S. A.) Robert E. Lee made a survey and map of the rapids, submitting at the same time various plans of improvements. Subsequently Lieut. (since Maj. Gen. U. S. A.) G. K. Warren extended the investigation, and made more professional researches into the practicability of making the rapids navigable. It was left to Brevet Major General J. H. Wilson to carry out the only feasible plan for the long looked-for passage across the lower rapids. General Wilson was assigned, in 1866, to the charge of the Des Moines and Rock Island rapids of the Mississippi river. The improvement, as carried out by him, consists of an independent ship canal, seven and six-tenths miles long, reaching on the Iowa side of the river from Nashville to Keokuk, to be two hundred and fifty feet wide in excavation, and from three hundred to four hundred feet in embankment; in extreme low water to have a depth of five feet.

In this canal will be three locks—one guard lock at the upper end, and two lift locks. The lower lock at Keokuk, to have a lift of ten and three-quarters feet; the middle lock two miles above, with a lift of eight feet. The guard lock will be so con-

structed that in very high water it, too, can be used as a lift lock. Each lock is to be three hundred and fifty feet between the mitre sills, eighty feet wide in the chamber, and to be filled through culverts leading from each gate recess, and passing in rear of the main walls, discharging through openings in the chamber walls. It is expected to fill each lock in three or five minutes. The canal is excavated to such a depth, and the embankment wells raised to such a height, as to meet the requirements of the low and high waters of 1864 and 1851, respectively. The difference between the above stages of water at Keokuk is twenty and seventy-two hundredths feet. As a consequence, extraordinary provisions must be made to prepare for these two extremes.

The river embankment of the canal consists of the best earth, protected by a well laid rip-rap (slope) wall. When completed it will be ten feet wide on top, and the sides having the slope of one and one-half base to one vertical on outside, and one and one-quarter to one on inside, giving an average height of twenty feet, and will be two feet above high-water mark of 1851. The bank is constructed by first throwing in broken stone to such a height above water as to warrant the safety of laying a track upon it. This "toe," or base of rip-rap, forms a nucleus, on the inside of which earth is thrown. This is widened and raised to the required dimensions. When this becomes water-tight, cross-banks are constructed from the river bank to the shore line, at irregular intervals to enclose the portions requiring excavation. A series of pits are thus enclosed, which are pumped dry, and the prism of the canal is brought to the required grade. The material thus excavated goes to form bank and wall in other places; by this means no material is wasted. When the earth embankment is completed, and excavation done, the cross-banks are removed and water let in.

The locks are constructed of the best magnesian limestone, laid in hydraulic cement. The stone is quarried in the line of bluffs adjacent to the rapids. It is of the best quality, and before acceptance into the work, each stone passes through a

rigid inspection by an engineer in charge. The walls of the lower lock are to be twenty-three and five-twelfths feet high ; middle lock, twenty feet ; and guard lock from eighteen to twenty feet. All of them ten feet wide on bottom, six feet wide on top and provided with suitable buttresses. The face of the chamber has a batter of one-half inch to one foot. Wooden gates, with iron heel-posts and quoin-plates will be supported by iron suspension posts held in position by rods anchored into the masonry. A stationary steam engine, by means of appropriate shaftings, will open and close the gates and wickets.

This completes the general plans of the improvement. The carrying out of the details is the work of time, of much labor, and requiring patience to battle the elements. The cost of the entire work, inclusive of the Montrose work, was estimated by General Wilson, in 1866, to be \$2,710,000. Of this amount \$1,380,000 has already been appropriated by Congress, inclusive of the \$200,000 obtained in the early part of the past winter. This amount will be expended before the 1st of July, 1870. The time required to construct the work will depend to a great extent upon the will of Congress. If suitable appropriations are made, it *can be* completed in one and one-half years. If not, it is impossible to tell when a boat can go through the canal. It is poor economy on the part of the general government to make small appropriations for this improvement. The locks, the canal, and the channel excavation at Montrose and above^v Nashville, can be carried on simultaneously, without interfering in the least with one another. If small and inadequate appropriations are made, the work progresses slowly, much material is lost by high water, and the contingent expenses increase annually.

Roughly estimated, three-fifths of the canal work are finished. One (the lower) lock is half completed. There is nothing done at either of the other locks ; nothing at Montrose. A great portion of the stone is delivered for the three locks. The cost of the maintenance of the canal will be insignificant for many years to come. A dredge for the canal, and an (steam) engineer at each lock, are all the positive expenses.

The water can be drawn out of the two levels in the winter, and canal cleaned. Several small streams empty into the canal; deposits from their waters will be held by suitable "catch-pools" in their basins near the outlet.

The present contractors for the canal work, are Messrs. Dull and Williams, of Keokuk; for the lower lock, E. Owen, of Albany, N. Y.; for the furnishing and delivery of stone, Messrs. Case and Van Wagener, of Fulton, N. Y.; for castings, Morris Sellers, of Keokuk; for cement, James Clark, of Utica, Ills.; and for timber, James Carroll, of Cairo, Illinois.

For a detailed statement of expenditures, reports of operations, &c., reference can be had to the annual reports of Brevet Major General A. A. Humphreys, Chief of Engineers, U. S. A., for the years 1867, 1868, 1869, and 1870.

During the past year an average daily force of one thousand men have been employed. Payments are made soon after each monthly estimate is taken. Wages have been higher than upon any other work in this portion of the country. From one-third to two-thirds of the employes are Swedes. The river bank is dotted with the rustic abodes of these workmen. Shanties built by the contractors are rented to the men at low figures. This offers inducements for permanent location, and drives away, to a certain extent, the ordinary river roustabouts.

A visit to the Des Moines Rapids Improvement is profitable in its results to the engineer, geologist, artist, and tourist.

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